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BY

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USE OF WESTERN MAGNETITE AS SHIP BALLAST[1]

By C. L. Severy[2]

INTRODUCTION

On the Pacific coast during World War II, a tremendous ship-building industry was developed. Early in the war it became impossible to obtain ingot or steel scrap for ship ballast. Magnetite, an oxide of iron, was substituted as it fulfilled the requirements of weight for available space in the ships. Consequently, a new use for the western magnetite was rapidly developed.

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USE AS SHIP BALLAST

There are three kinds of ship ballast:

1. Permanent ballast in the bottom of ships.
2. Movable ballast, anchored wherever needed to ballast a ship.
3. Ballast in loose form, loaded into the hold and boarded over to give the ship weight when lacking sufficient cargo.

Magnetite was used for the first two classifications.

When it is known for what purpose a ship will be used, it can be designed to require the minimum amount of ballast. During the war, Victory ships were made on a mass production-line scale, and their ultimate uses were variable. A ship designed as a cargo carrier might suddenly be converted into a troop ship or into one for carrying very light cargo, such as airplanes, or even converted into a small flat-top combat-plane carrier. In such cases, considerable movable ballast had to be added. Magnetite filled the requirements, both for permanent ballast and movable blocks.

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The firm of Carrico & Gautier of San Francisco supplied the major part of the magnetite ship ballast used on the Pacific coast from Seattle to Los Angeles. In 1942, this firm opened a mine in Shasta County and built a plant to process the ore. A mixing plant was constructed for casting blocks and to furnish a ready mix for permanent ballast to the various shipyards.

The average specific gravity of the magnetite used was 4.5. The specifi gravity of pig iron is about 7.5. However, the difference in the use of magnetite is not as marked as this would indicate. With the use of pig iron, large spaces are left between ingots which cannot be filled due to their shap This is even more marked in the case of steel scrap. The magnetite concrete mix is either poured into the space and completely fills it, or it is cast in close-fitting shapes which practically fill the entire space and occupies little more actual room than that required for pig-iron ingots. The finished weight of the magnetite concrete is 230 to 235 pounds per cubic foot or about half that of pig iron.

The magnetite is prepared in the same way as any aggregate for concrete. It is crushed to 2-1/2 inches and sized over screens into three classifications, fines up to 1/4 inch, 1/4 inch to 1 inch, and 1 inch to 2-1/2 inches. To meet the strength requirements, 4 to 5 sacks of cement are used per cubic yard. This mix developed two-thirds of the strength of regular concrete. It was found that, when failures occurred, the fractures extended through the ore and binder and not just in the binder around the ore.

The requirements of a ship for permanent ballast are calculated by the engineers at the shipyards, and an order is given for the mix. The magnetite aggregate is made in a mixing plant, furnished the shipyard as a ready mix, and poured into the ship through chutes or elephant trunks and by dump bucket or by buggies, depending on the conditions. Movable ballast is mixed in the same way and cast into blocks usually 9 by 11 by 13 inches and weigh about 17 pounds for easy handling. The blocks are very useful in distributing the weight where needed when a ship is converted from one use to another.

C-2 cargo ships, of 8,000 tons register, for the United Kingdom, used ir the North Atlantic invasions required 3,000 long tons of ballast. Victory ships of 10,000 tons register, originally designed as cargo carriers but converted to troop transports, required 1,000 long tons of ballast.

Near the close of the war, pig-iron ingots again became available on the Pacific coast because of production from the Geneva steel plant in Utah and the Kaiser steel plant at Fontana, Calif. The specifications on 119 Victory ships called for pig iron as ballast, but were changed so that magnetite ballast could be used. It was demonstrated that there was a great saving in cost by this change. It was estimated that, in Pacific Coast shipping, the substitution of magnetite for pig iron as ballast saved at least $2,000,000.

Since the war it has been demonstrated that magnetite serves adequately as ship ballast and is less costly than the pig-iron ingots. Although curtailment of new ship construction has limited the use of magnetite, it is now being placed in new ships as they are built. The ships of the American President Line under construction are using magnetite as ballast.

ORE DEPOSITS

There are many deposits of magnetite in California that are not large enough to support a blast-furnace operation but can be used to supply ship ballast. The ore must be compact and hard and assay above 60 percent iron. To meet these specifications, considerable selective mining and sorting are necessary.

The sources of the magnetite used on the Pacific coast were as follow: Carrico & Gautier of San Francisco furnished 300,000 tons from its Shasta County mine from 1942 through 1945. In southern California, 2,000 tons came from the Bessemer mine in San Bernardino County and 13,000 tons from Eagle Mountain in Riverside County. It was supplied by the Minerals Materials Co. of Alhambra to Carrico & Gautier for processing and delivery to the shipyards in that area. Dodge Bros. of San Francisco mined 30,000 to 35,000 tons of magnetite in Nevada, shipping 20,000 tons to the Richmond shipyards and the balance to Portland, Oreg. The Bender Roofing & Paving Co. of San Francisco, furnished 10,000 tons of fine beach magnetite concentrates from its plant in Santa Cruz County. The concentrates were used with the coarse Nevada ores in making up the concrete aggregate.

About 83 percent of the ore used on the Pacific coast for ship ballast was mined from the Shasta and California iron-ore deposits, Shasta County, Calif. This is a contact deposit between the McCloud limestone and a younger granitic intrusion. The ore occurs as irregular masses, pods, and disseminations of magnetite in skarn, a contact metamorphic rock composed largely of garnet, pyroxene, and epidote.

Mining is by open pit, with 10- to 16-foot benches, and Diesel-powered revolving shovels are used for loading. The shovel operators become rather adept at selectively scooping clean ore. Mixed ore is dumped in piles and hand-sorted. Ore shipments assayed better than 62 percent iron. An average of 7-1/2 tons of material was moved to obtain 1 ton of magnetite of the grade meeting the specifications for ship ballast. The other deposits from which magnetite ballast ore was shipped are similar geologically.

CONCLUSIONS

Magnetite aggregate in concrete poured into the holds of ships or in blocks has proved to be a satisfactory and economical substitute for pig-iron ingots or steel scrap for ballasting ships. About 360,000 tons of ore went into this industry during the war. All the magnetite ballast for the shipyards on the entire Pacific coast was supplied by the California mines, with the exception of 35,000 tons mined in Nevada. It is thought by those in the industry that this type of ballast will compete successfully with pig-iron ingots or steel scrap and will continue to be used, particularly in new ship construction

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